Thompson, R.L. and D.B. Poindexter. 2011. Species richness after *Lonicera maackii* removal from an old cemetery macroplot on Dead Horse Knob, Madison County, Kentucky. Phytoneuron 2011-50: 1–16. Published 10 Oct 2011. ISSN 2153 733X

SPECIES RICHNESS AFTER *LONICERA MAACKII* REMOVAL FROM AN OLD CEMETERY MACROPLOT ON DEAD HORSE KNOB, MADISON COUNTY, KENTUCKY

RALPH L. THOMPSON[1, 2]
[1] Hancock Biological Station
Murray State University
Murray, Kentucky 42071
[2] Berea College Herbarium, Biology Department
Berea, Kentucky 40404
ralph_thompson@berea.edu

DERICK B. POINDEXTER
I.W. Carpenter, Jr. Herbarium
Appalachian State University, Biology Department
Boone, North Carolina 28608
poindexterdb@appstate.edu

ABSTRACT

The predominance of *Lonicera maackii* (Rupr.) Herder (Amur Honeysuckle) in central Kentucky has made it a significant invasive for continued community interaction studies. To better understand the dynamics of vegetation succession with respect to this species and overall species richness, quantitative floristics of two macroplots were made at the summit (312 m) of Dead Horse Knob (Rucker's Knob) near Berea, in Madison County, east-central Kentucky. An old abandoned cemetery was cleared of *L. maackii* and a macroplot (20 x 12 m) served as a test plot, while a second macroplot was placed within a dense thicket of *L. maackii* to serve as a reference plot. Thirty quadrats (1 x 1 m) were randomly placed within each macroplot as a means to determine species frequency. A full floristic survey was then conducted of each macroplot. Results from frequency data suggest that native annual and perennial species will quickly recolonize an area after removal of Amur Honeysuckle and become the most important components of the site. Likewise, floristic data demonstrated nearly a three-fold increase in species richness (60 taxa) in the test macroplot after removal of Amur Honeysuckle compared to species richness (21 taxa) in the reference macroplot. In the absence of Amur Honeysuckle, vegetation has resulted in a significantly different floristic assemblage between macroplots. Frequency data from the cleared test macroplot indicate that *L. maackii* will remain viable through seedling recruitment, and without further control or disturbance, an understory thicket of Amur Honeysuckle will undoubtedly be reestablished at this site.

KEY WORDS: Amur honeysuckle, exotics, invasives, Kentucky, *Lonicera maackii*, species richness

The most aggressive invasive species with the greatest deleterious impact on the total vegetation and native plants in central Kentucky is undoubtedly *Lonicera maackii* (Rupr.) Herder (Amur Honeysuckle). In east-central Kentucky, Campbell et al. (1995) noted that *L. maackii* was the most abundant, widespread exotic shrub in successional forests at Raven Run Nature Sanctuary in adjacent Fayette County. Thompson et al. (2005) and Thompson and Green (2010) reported the abundance and aggressive impact of *L. maackii* on the floristic composition and habitats in two studies of abandoned limestone quarries in the Outer Bluegrass Region of contiguous Clark County and Garrard County. In neighboring Ohio, Amur Honeysuckle is considered the most abundant naturalized shrub in the Greater Cincinnati region (Luken & Thieret 1995). Its severe impact on the flora and natural vegetation of the eastern USA has become extremely detrimental in reducing native herbaceous

cover, shrub and tree seedlings, and species diversity (Gorchov & Trisel 2003; Rundle et al. 2007; Clark & Weckman 2008).

Luken and Thieret (1995) presented a 150-year chronology of the interaction between people and the introduction of *Lonicera maackii*, an invasive east Asian shrub from the Amur River region of Manchuria. Amur Honeysuckle is a fast-growing, multi-stemmed, deciduous shrub up to 6 meters high that produces attractive axillary flowers and red berries in the leaf axils of opposite simple leaves. The fruits are readily disseminated by avian vectors (Ingold & Craycraft 1983; Bartuszevige & Gorchov 2006). This shrub was introduced into North America in 1896 and was much used in horticultural settings and as an ornamental landscaping plant; ironically, *L. maackii* was initially promoted by the USDA Soil Conservation Service (Luken & Thieret 1995, 1996). Amur Honeysuckle was much planted in arboreta, botanical gardens, parks, college and university campuses, government plots, and by the general public until the 1960s. By 1994, Amur Honeysuckle had migrated into at least 24 states (Trisel & Gorchov 1994). Unfortunately, even though its disastrous influences on natural plant communities have been repeatedly documented, *L. maackii* continues to be sold by numerous plant nurseries as a garden and landscaping plant in the USA according to an Internet search of active websites.

Research focusing on competition and allelopathic effects of *Lonicera maackii* on native flora and natural vegetation, its persistent migration, as well as mechanisms for the control of this invasive species have been extensively documented in recent literature from Kentucky (e.g., Luken 1988; Luken & Mattimiro 1991; Luken & Goessling 1995; Luken et al. 1995a, 1995b; Luken et al. 1997), and Ohio (e.g., Ingold & Craycraft 1983; Trisel & Gorchov 1994; Hutchinson & Vankat 1997, 1998; Medley 1997; Trisel 1997; Deering & Vankat 1999; Gould & Gorchov 2000; Gayek & Quigley 2001; Collier et al. 2002; Gorchov & Trisel 2003; Hartman & McCarthy 2004; Miller & Gorchov 2004; Bartuszevige & Gorchov 2006; Dorning & Cipollini 2006; Runkle et al. 2007).

Regardless of the large amount of current research (as exemplified above) that has provided ample evidence for a focused management of Amur Honeysuckle, it is still only regionally regarded as an invasive plant pest (MA-EPPC 2011; SE-EPPC 2011). It has yet to be recognized as a Kentucky or Federal Noxious Weed (see USDA, NRCS 2011). Nevertheless, this is not an unusual issue since other severe invasive species [e.g., *Persicaria perfoliata* (L.) H. Gross (Mile-a-minute-vine)] have yet to be Federally listed despite their rampant spread (Poindexter 2010). In consideration of this, it seems rational to continue to produce studies such as this one to help elucidate the impacts of Amur Honeysuckle on local vegetation.

We conducted a quantitative floristic study on the summit of Dead Horse Knob in east-central Kentucky, during the summer of 2011. Our objectives were to: 1) determine frequency of taxa through 30 (1 x 1 m) quadrats each within two 20 x 12 m macroplots (one a test plot and one a *Lonicera maackii* reference plot) for species richness, species composition, and overall floristic diversity; 2) survey the two macroplots for species not present in quadrats; 3) document the competitive effects of *L. maackii* as a means to provide further data on its negative impact on native flora and vegetation; and 4) promote the need for elevating this species to the forefront of controlled management efforts in the eastern USA.

THE STUDY SITE

Dead Horse Knob (hereafter DHK or knob) is an isolated, dome-shaped, solitary 2.6-ha "knob" near the city of Berea within southern Madison County, Kentucky (Figure 1). The DHK site is a part of the 270-ha Berea College Farm and is surrounded by open agriculture and pasture land (Thompson et al. 2008). It lies within the Knobs-Norman Upland Ecoregion of the Interior Plateau

Physiographic Province (Woods et al. 2002) at 37.583591°N and 84.298871°W (Figure 1). Vegetation in this ecoregion is highly altered Oak-Hickory Forest (Woods et al. 2002).

The study site is located at the summit (312 m) of DHK where a dense thicket of *Lonicera maackii* constitutes much of the understory cover throughout the highly disturbed Dry-Mesic Oak-Hickory Forest. On the DHK summit, Coyler shaly silt loam is the shallow, strongly acid (4.5-5.0 pH), excessively well-drained soil derived from weathered Devonian New Albany shale (Weir 1969). While identified on topographic maps as Dead Horse Knob, it is also recognized as Rucker's Knob by many local people due to a small private cemetery, the Pullins-Rucker Cemetery, on the knob crest. The family cemetery began with the interment of a Revolutionary War veteran, Loftus Pullins, Jr. (1764-1841), and some of his descendents.

The cemetery understory was covered by Amur Honeysuckle along with a few other invasive woody plants, a few pole-sized and mature canopy trees, and a very sparse herbaceous layer. The shrubbery was partially removed from the cemetery in September of 1981 for a commemorative ceremony held by the Madison County DAR and SAR (Daughters and Sons of the American Revolution) organizations on November 8, 1981, to recognize the contributions of Loftus Pullins, Jr. and to dedicate a flat marble monument to his memory.

Afterwards, the cemetery soon was abandoned and secondary succession was allowed to occur. Over the next 30 years, the Pullins-Rucker Cemetery understory became dominated by a dense thicket of *Lonicera maackii* and other invasive shrubs and vines including *Lonicera japonica*, *Euonymus fortunei*, *Ligustrum obtusifolium*, and *Celastrus orbiculatus*. These five Old World woody taxa meet the criteria as novel, invasive colonizers by the definition of Davis and Thompson (2000), i.e., they are truly long-distance colonizers aggressively expanding their geographical range and having severe impacts on their environment.

Figure 1. Dead Horse Knob (Rucker' Knob), in Madison County, Kentucky. Pullins-Rucker Cemetery in red-outlined rectangle (not to scale). Map adapted from Google Earth, 2010 DigitalGlobe. Image from January 14, 2004.

METHODS

On September 10, 2010, the Amur Honeysuckle thicket was removed with a chain saw and hand clippers in the cemetery area to expose the flat graveyard headstones (Figure 2A). The eventual intent was to clear the cemetery of all woody plants, except healthy canopy trees, and to build a wooden fence around the cemetery. At the time of brush removal, an inventory of all native and exotic herbaceous and woody taxa observed was recorded. By the following April 14, 2011, the cleared area had been colonized by the invasive *Stellaria media* and a lush regrowth of *Lonicera maackii* from stump sprouts, new subterranean shoots, and emerging seedlings.

On May 17, 2011, an area encompassing 25 x 15 m in the cemetery was carefully cleared of understory Amur Honeysuckle, other woody invaders, and all tree saplings by hand clippers and chain saw. Cut-stumps were then treated with undiluted Tordon® RTU Specialty Herbicide from Dow AgroSciences™. By mid-July 2011, all treated stumps essentially showed a 100% kill from the active ingredients, Picloran (4-amino-3, 5, 6-trichloropicolinic acid) and 2, 4-dichlorophenoxyacetic acid.

Two 20 x 12 m macroplots were laid out with end steel rods and heavy cord twine on August 24 and 25, 2011. The first macroplot boundary (Figure 2A) was placed within the initial 25 x 15 m cleared cemetery (hereafter, cemetery test macroplot). The second macroplot (Figure 3A) was placed in an adjacent dense understory thicket of non-altered *Lonicera maackii* (hereafter, the Amur Honeysuckle reference macroplot).

Thirty 1 x 1 m cemetery test quadrats and 30 (1 x 1 m) Amur Honeysuckle reference quadrats were randomly placed within the two macroplots. Frequency was determined for all living rooted herbaceous and woody plants within the sampling quadrats. This quantitative method was derived from Wu et al. (2002):

$$\text{Frequency} = \frac{\text{Number of quadrats in which a species occurs}}{\text{Total number of quadrats taken}} \times 100$$

Frequency is the proportion of the number of samples (i.e., 1 x 1 m quadrats, n=30 quadrats per macroplot) in which a given species occurs expressed as a percentage. Frequency is a measure of the abundance and distribution of a species within a study area (i.e., 20 x 12 m macroplots, n=2 macroplots). A frequency value gives information to where the species is located and its probability of occurring. After quadrat frequency data were gathered, the two macroplots were completely inventoried for taxa not occurring within the 60 quadrats.

A floristic similarity between macroplots was determined using the strategy of Barbour et al. (1999), whom presented the Sørenson's Community Coefficient (CC) or Index of Similarity (IS) method to determine the degree of floristic congruence between two sites of vegetation based on taxon presence only.

$$\text{Sørenson's Community Coefficient (CC)} = \frac{2 \times (\text{number of species common to both A+B})}{\text{Total species plot A} + \text{Total species plot B}} \times 100$$

An annotated list of taxa in this study was compiled with four relevant attributes: 1) origin (native or exotic), 2) growth duration and habit, 3) macroplot(s) occurrence; and 4) voucher specimen documentation (see Appendix). Nomenclature follows Weakley (2011).

Figure 2. Cemetery test macroplot. (A) After removal of *Lonicera maackii* on September 10, 2010, and (B) secondary successional plant colonization on September 17, 2011.

Figure 3. (A) Margin of the Amur Honeysuckle reference macroplot with a scarcity of plants within the herb layer, and (B) margin of the Cemetery test macroplot with a substantial herb layer. Images were taken on September 17, 2011.

RESULTS AND DISCUSSION

Cemetery Test Macroplot.

The 30 cemetery test quadrats contained 51 different species (19 exotics) from 46 genera in 26 families with a total count of 323 individual plants (Table 1). The most important colonizing taxa in the test quadrats with 50% frequency or greater were *Phytolacca americana*, *Oxalis stricta*, *Solanum ptychanthum*, *Erechtites hieraciifolius*, *Persicaria longiseta*, and *Ailanthus altissima* (Table 1; Figures 2B & 3B). An additional nine taxa, *Carex blanda*, *Commelina diffusa*, *Eclipta prostrata*, *Chamaesyce maculata*, *Panicum dichotomiflorum*, *Passiflora incarnata*, *Persicaria maculata*, *Smilax bona-nox,* and *Vernonia gigantea*, were collected within the cemetery macroplot but not recorded within the 30 cemetery test quadrats. Thus, a total of 60 taxa were documented for the test macroplot.

Amur Honeysuckle Reference Macroplot.

The 30 Amur Honeysuckle reference quadrats had only 21 species present (seven exotics) from 18 genera in 15 families with a total count of 110 individual plants (Table 2). The most prominent taxa within the reference plot quadrats with at least 50% frequency were *Lonicera maackii* and *L. japonica*. Twenty of 21 taxa in the Amur Honeysuckle quadrats were present in the cemetery quadrats including all seven exotics (Table 3). A single *Acer saccharum* seedling in an Amur Honeysuckle quadrat was not present in the cemetery quadrats (Table 3). No other species were documented outside of the quadrats within this reference macroplot. The herbaceous layer is sparse under the Amur Honeysuckle thicket (Figure 3A).

Floristic Comparisons.

Species richness was substantially higher in the cemetery test macroplot with 60 documented taxa (Table 1) versus only 21 within the Amur Honeysuckle reference macroplot (Table 2). Despite the difference in total taxa for each macroplot, both contained proportionately similar numbers of exotics (cemetery test macroplot = 31.6%, Amur Honeysuckle reference macroplot = 33.3%).

The IS for these two study sites was 55.6% based on quadrat presence only, but 49.4% when the additional collection records outside of the quadrats were included. Any two sites with an IS of 50% or greater are considered to be of the same vegetation type. The biological reality of the two macroplots is best represented by the full floristic composition of both macroplots. Thus, the differences between the two plots were great enough to consider them as significantly different based on species composition.

Species Richness and Origin of Taxa.

The species richness from the two 20 x 12 m macroplots combined was 61 taxa (38 herbs, 23 woody), which included 20 naturalized species (32.79%). The 38 herbaceous taxa comprised 25 annuals/biennials (14 exotics), 12 perennials (one exotic), and one perennial vine. The 23 woody taxa consisted of seven vines (three exotics), four shrubs (two exotics), and 11 trees (one exotic). Fourteen of the 21 naturalized taxa are state-listed by the KY-EPPC (2011). The nine "severe threat" invasive plants are *Ailanthus altissima*, *Carduus nutans*, *Celastrus orbiculatus*, *Euonymus fortunei*, *Ligustrum obtusifolium*, *Lonicera japonica*, *Lonicera maackii*, *Microstegium vimineum*, and *Stellaria media.* Three "significant threat" taxa with invasive characteristics are *Persicaria longiseta*, *Persicaria maculosa*, and *Setaria faberi*, and the two "lesser threat" taxa are *Commelina communis* and *Echinochloa crusgalli* var. *crusgalli.*

Secondary Succession.

Several woody taxa observed after Amur Honeysuckle was cleared from the cemetery on September 10, 2010, included *Euonymus fortunei*, *Ligustrum obtusifolium*, *Lonicera japonica*, *Lonicera maackii*, *Parthenocissus quinquefolia*, *Symphoriocarpos orbiculatus*, *Toxicodendron radicans* var. *radicans*, and *Vitis vulpina.* Eight of these nine shrubs and vines were present in

quadrats sampled from both the cemetery macroplot (Table 1) and Amur Honeysuckle macroplot (Tables 2 & 3), except for *Ligustrum obtusifolium* in the cemetery macroplot. Some native and exotic herbaceous and tree seedling volunteers had propagules present in the seed bank (seed pool) before the September 2010 clearing. Seven herbs observed before Amur Honeysuckle removal in 2010 were *Bidens bipinnata*, *Commelina communis*, *Lobelia inflata*, *Oxalis stricta*, *Persicaria longiseta*, *Phytolacca americana*, and *Stellaria media*. These woody and herbaceous taxa invariably had propagules present in the seed bank before removal.

Volunteering taxa with light-weight, wind-carried fruits and seeds were able to quickly colonize the cemetery after Amur Honeysuckle removal (Figures 2B & 3B). Native or exotic herbaceous taxa found in the cemetery quadrats from one growing season included 14 members of Asteraceae (*Ambrosia artemisiifolia*, *Bidens bipinnata*, *Bidens frondosa*, *Carduus nutans*, *Conoclinum coelestinum*, *Conyza canadensis* var. *canadensis*, *Erechtites hieraciifolius*, *Eclipta prostrata*, *Eupatorium serotinum*, *Galinsoga quadriradiata*, *Sonchus asper*, *Taraxacum officinale*, *Verbesina alternifolia*, and *Vernonia gigantea*), seven taxa of Poaceae (*Digitaria ischaemum*, *Digitaria sanguinalis*, *Echinochloa crusgalli* var. *crusgalli*, *Microstegium vimineum*, *Panicum dichotomiflorum*, *Setaria faberi*, and *Setaria pumila*), *Cyperus strigosus*, *Lobelia inflata*, *Oxalis stricta*, *Persicaria longiseta*, *Persicaria maculosa*, *Stellaria media*, and *Verbena urticifolia* var. *urticifolia*, among others (Table 1; Appendix). *Commelina communis*, *Persicaria longiseta*, *Microstegium vimineum*, and *Stellaria media* were annuals with light-weight seeds within the non-altered Amur Honeysuckle reference quadrats (Table 2). Tree seedlings with wind-carried samaras were *Acer rubrum* var. *rubrum*, *Acer saccharum*, *Ailanthus altissima*, and *Fraxinus americana*.

Trees with heavier diaspores distributed by gravity and/or animals (mainly birds and mammals) are *Celtis occidentalis*, *Gleditsia triacanthos*, *Nyssa sylvatica*, *Quercus alba*, *Quercus velutina*, *Prunus serotina* var. *serotina*, and *Robinia pseudoacacia*, while shrubs, woody vines, and perennials with gravity-dispersed and/or animal-dispersed fruits and seeds include *Ligustrum obtusifolium*, *Lonicera japonica*, *Lonicera maackii*, *Parthenocissus quinquefolia*, *Phytolacca americana*, *Rubus pensilvanicus*, *Sambucus canadensis*, *Symphoriocarpos orbiculatus*, *Toxicodendron radicans* var. *radicans*, and *Vitis vulpina*. No state-listed taxa were encountered in the two macroplots (KSNPC 2010).

CONCLUSIONS

Our quantitative floristic frequency data and observations support conclusions in literature that removal of *Lonicera maackii* allows for a large increase in species richness and overall species composition primarily because of increased insolation and decreased competition from Amur Honeysuckle through shade-release. The dense growth habit and allelopathic defenses of this taxon make it a more efficient competitor than many other invasive species and certainly all the native species. As evidenced by the *Lonicera maackii* seedling recruitment in the cemetery test macroplot, reestablishment of another understory thicket of Amur Honeysuckle is eminent in a short time without further control measures. In short, well-known "novel" invasive plant colonizers, such as *Lonicera maackii*, have severely influenced litter decomposition, disturbed soil nutrient cycles, replaced the native flora and vegetation, changed patterns of seedling germination, reproduction, and regeneration, and altered overall secondary plant succession in their respective environments (Poindexter & Thompson 2009).

Although our floristic quantitative study at DHK is determined from only a small sample of quadrat frequency data and personal observations, the density of *Lonicera maackii* has significantly lowered species richness and species diversity of native annual and perennial herbs, shrubs, and tree seedlings to be expected in the Oak-Hickory Forest communities of east-central Kentucky. These deleterious effects are markedly evident when DHK is compared to a pristine area within the Berea

College Forest, the Anglin Falls Ravine in adjoining Rockcastle County, which has very high species richness and is currently without any Amur Honeysuckle-infestation (Thompson & Fleming 2004).

ACKNOWLEDGEMENTS

We wish to thank Drs. Guy Nesom and J. Richard Abbott for their critical reviews of our manuscript. This study is part of a complete floristic survey of the 2.6-ha Dead Horse Knob to further add biodiversity documentation for an area of social and historical significance in Kentucky.

LITERATURE CITED

Barbour, M.G., J.H. Burk, W.D. Pitts, F.S. Gilliam, and M.W. Schwartz. 1999. Terrestrial Plant Ecology (ed. 3). Benjamin/Cummings, Inc., Menlo Park, California.

Bartuszevige, A.M. and D.L. Gorchov. 2006. Avian seed dispersal of an invasive shrub. Biol. Invasions 8: 1013–1022.

Campbell, J.J.N., D.G. Ruch, and W. Meijer. 1995. Flora and vegetation of Raven Run Nature Sanctuary, Fayette County, Kentucky. Proc. Indiana Acad. Sci. 104: 139–184.

Clark, R.C. and T.J. Weckman. 2008. Annotated catalog and atlas of Kentucky woody plants. Castanea, Occasional Paper in Eastern Botany No. 3: 1–114.

Collier, M.H., J.L. Vankat, and M.R. Hughes. 2002. Diminished plant richness and abundance below *Lonicera maackii*, an invasive shrub. Am. Midl. Nat. 147: 60–71.

Davis, M.A. and K. Thompson. 2000. Eight ways to be a colonizer; two ways to be an invader: a proposed nomenclature scheme for invasion ecology. Bull. Ecol. Soc. Am. 81: 226–230.

Deering, R.H. and J.L. Vankat. 1999. Forest colonization and developmental growth of the invasive shrub *Lonicera maackii*. Am. Midl. Nat. 141: 43–50.

Dorning, M. and D. Cipollini. 2006. Leaf and root extracts of the invasive shrub, *Lonicera maackii*, inhibit seed germination of three herbs with no autotoxic effects. Plant Ecol. 184: 287–296.

Gayek, A. and M.F. Quigley. 2001. Does topography affect the colonization of *Lonicera maackii* and *Ligustrum vulgare* in a forested glen in southwestern Ohio? Ohio J. Sci. 101: 95–100.

Gorchov, D.L. and D.E. Trisel. 2003. Competitive effects of the invasive shrub, *Lonicera maackii* (Rupr.) Herder (Caprifoliaceae), on the growth and survival of native tree seedlings. Plant Ecol. 166: 13–24.

Gould, A.M.A. and D.L. Gorchov. 2000. Effects of the exotic invasive shrub *Lonicera maackii* on the survival and fecundity of three species of native annuals. Am. Midl. Nat. 144: 36–50.

Hartman, J.M. and B.C. McCarthy. 2004. Restoration of a forest understory after the removal of an invasive shrub, Amur honeysuckle (*Lonicera maackii*). Restor. Ecol. 12: 154–165.

Hutchinson, T.L. and J.L. Vankat. 1997. Invasibility and effects of Amur honeysuckle in southwestern Ohio forests. Conservat. Biol. 9: 416–425.

Hutchinson, T.L. and J.L. Vankat. 1998. Landscape structure and spread of the exotic shrub *Lonicera maackii* (Amur honeysuckle) in southwestern Ohio forests. Amer. Midl. Nat. 139: 383–390.

Ingold, J.L. and M.J. Craycraft. 1983. Avian frugivory on honeysuckle (*Lonicera*) in southwestern Ohio. Ohio J. Sci. 83: 256–258.

KSNPC (Kentucky State Nature Preserves Commission). 2010. Rare and extirpated biota of Kentucky. J. Kentucky Acad. Sci. 61: 115–132.

KY-EPPC (Kentucky Exotic Pest Plant Council). 2011. Kentucky Exotic Plant Pest Council invasive exotic plant list. <http://www.se-eppc.org/ky/list.htm> Accessed 25 Sep 2011.

Luken, J.O. 1988. Population structure and biomass allocation of the naturalized shrub *Lonicera maackii* (Rupr.) Maxim. in forest and open habitats. Amer. Midl. Nat. 119: 258–267.

Luken, J.O. and N. Goessling. 1995. Seedling distribution and potential persistence of the exotic shrub *Lonicera maackii* in fragmented forests. Amer. Midl. Nat. 133: 124–130.

Luken, J.O., L.M. Kuddes, and T.C. Tholemeier. 1997. Response of understory species to gap formation and soil disturbance in *Lonicera maackii* thickets. Restor. Ecol. 5: 229–235.

Luken, J.O. and D.T. Mattimiro. 1991. Habitat-specific resilience of the invasive shrub Amur honeysuckle (*Lonicera maackii*) during repeated clipping. Ecol. Appl. 1: 104–109.

Luken, J.O. and J.W. Thieret. 1995. Amur honeysuckle (*Lonicera maackii*; Caprifoliaceae): its ascent, decline, and fall. Sida 16: 479–503.

Luken, J.O. and J.W. Thieret. 1996. Amur honeysuckle, its fall from grace. BioScience 46: 18–24.

Luken, J.O., T.C. Tholemeier, L.M. Kuddes, and B.A. Kunkel. 1995a. Performance, plasticity, and acclimation of the nonindigenous shrub *Lonicera maackii* (Caprifoliaceae) in contrasting light environments. Canad. J. Bot. 73: 1953–1961.

Luken, J.O., T.C. Tholemeier, B.A. Kunkel, and L.M. Kuddes. 1995b. Branch architecture plasticity of Amur honeysuckle (*Lonicera maackii* (Rupr.) Herder): initial response in extreme light environments. Bull. Torrey Bot. Club 122: 190–195.

MA-EPPC (Mid-Atlantic Exotic Plant Pest Council). 2011. Mid-Atlantic Exotic Plant Pest Council plant list. <http://www.invasive.org/maweeds.cfm> Accessed 29 Sep 2011.

Medley, K.E. 1997. Distribution of the non-native shrub *Lonicera maackii* in Kramer Woods, Ohio. Phys. Geogr. 18: 18–36.

Miller, K.E. and D.L. Gorchov. 2004. The invasive shrub, *Lonicera maackii*, reduces growth and fecundity of perennial forest herbs. Oecologia 139: 359–375.

Poindexter, D.B. 2010. *Persicaria perfoliata* (Polygonaceae) reaches North Carolina. Phytoneuron 2010-30: 1–9.

Poindexter, D.B. and R.L. Thompson. 2009. Vascular flora and plant habitats of Wallace Woods, a hemlock-northern hardwoods palustrine forest, Crawford County, Pennsylvania. Rhodora 111: 231–260.

Runkle, J.R., A. DiSalvo, Y. Graham-Gibson, and M. Dorning. 2007. Vegetation release eight years after removal of *Lonicera maackii* in west-central Ohio. Ohio J. Sci. 107: 125–129.

SE-EPPC (Southeast Exotic Plant Pest Council). 2011. Invasive plants of the thirteen southern states. <http://www.invasive.org/seweeds.cfm> Accessed 29 Sep 2011.

Thompson, R.L., K. Rivers Thompson, E.A. Fleming, R.D. Cooks, J.R. Price, M.N. Naseman, and A.J. Oles. 2008. Eastern mistletoe (*Phoradendron leucarpum*, Viscaceae) in the city of Berea, Kentucky: a high incidence of infestation and eight new host species for Kentucky. J. Kentucky Acad. Sci. 69: 3–10.

Thompson, R.L., J.R. Abbott, and A.E. Shupe. 2005. Vascular flora from five plant habitats of an abandoned limestone quarry in Clark County, Kentucky. J. Kentucky Acad. Sci. 66: 24–34.

Thompson, R.L. and C.A. Fleming. 2004. Vascular flora and plant communities of the John B. Stephenson Memorial Forest State Nature Preserve (Anglin Falls Ravine), Rockcastle County, Kentucky. Castanea 69: 125–138.

Thompson, R.L. and S.R. Green. 2010. Vascular flora of an abandoned limestone quarry in Garrard County, Kentucky. Castanea 75: 245–258.

Trisel, D.E. 1997. The invasive shrub, *Lonicera maackii* (Rupr.) Herder (Caprifoliaceae): factors contributing to its success and its effect on native species. Ph.D. dissertation, Miami University, Oxford, Ohio.

Trisel, D.E. and D.L. Gorchov. 1994. Regional distribution, leaf phenology, and herbivory of the invasive shrub, *Lonicera maackii*. Bull. Ecol. Soc. Am. 75: 231–232.

USDA, NRCS. 2011. The PLANTS Database. National Plant Data Team, Greensboro, North Carolina. <http://plants.usda.gov> Accessed 24 Sep 2011.

Weakley, A.S. 2011. Flora of the Southern and Mid-Atlantic States. Working draft of 15 May 2011. Univ. of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, North Carolina.

Weir, G.W. 1967. Geologic map of the Berea Quadrangle east-central Kentucky. Map GQ-649. (Map scale 1:24,000), U.S. Geol. Survey, Washington, DC.

Woods, A.J., J.M. Omernik, W.H. Martin, G.J. Pond, W.M. Andrews, S.M. Call, J.A. Comstock, and D.D. Taylor. 2002. Ecoregions of Kentucky (color poster with map, descriptive text,

summary tables, and photographs. (Map scale 1:1,000,000). U.S. Geol. Survey, Reston Virginia.

Wu, X.B., F.E. Smeins, and R.D. Slack. 2002. Fundamentals of Ecology Laboratory Manual (ed. 3). edition. Kendall/Hunt Publishing Company, Dubuque, Iowa.

APPENDIX

The annotated list provides voucher records and selective characteristics of taxa documented in this study. Taxonomic concepts and nomenclature follow Weakley (2011). Exotic taxa are preceded by an asterisk (*) and invasive pest plants for Kentucky (KY-EPPC 2011) are indicated by a double asterisk (**). A plant found in the test macroplot, but not found in quadrats is indicated by a dagger (†). After the scientific name, a vernacular name from either Weakley (2011) or USDA, NRCS (2011) is given. Growth duration (annual, biennial, perennial) and habit (herb, graminoid, herbaceous vine, woody vine, shrub, tree) are designated after the scientific name and are adapted from USDA, NRCS (2011). Habit descriptors are followed by an occurrence designation for each macroplot: CTP = cemetery test plot and ACP = Amur Honeysuckle reference plot. An italicized voucher collection number ends each taxon entry.

ANGIOSPERMS: MONOCOTS

COMMELINACEAE, Spiderwort Family

****Commelina communis* L., Asiatic Dayflower. Annual herb; CTP, ACP. *11-650*

†***Commelina diffusa* Burmann f. , Creeping Dayflower. Annual herb; CTP. *11-652*

CYPERACEAE, Sedge Family

†*Carex blanda* Dewey, Eastern Woodland Sedge. Perennial graminoid; CTP. *10-354*

Cyperus strigosus L., Straw-Colored Flat-Sedge. Perennial graminoid; CTP. *11-651*

POACEAE, Grass Family

**Digitaria ischaemum* (Schreb.) Schreb. ex Muhl., Smooth Crab-Grass. Annual graminoid; CTP. *11-612*

**Digitaria sanguinalis* (L.) Scop., Hairy Crab-Grass. Annual graminoid; CTP. *11-644*

***Echinochloa crusgalli* (L.) P. Beauv. var. *crusgalli*, Barnyard Grass. Annual graminoid; CTP. *11-637*

***Microstegium vimineum* (Trin.) A. Camas, Nepalese Browntop. Annual graminoid; CTP, ACP. *10-941*

†*Panicum dichotomiflorum* Michx., Fall Panic Grass. Annual graminoid; CTP. *11-636*

***Setaria faberi* R.A.W. Herrm., Nodding Foxtail. Annual graminoid; CTP. *11-643*

**Setaria pumila* (Poir.) Roem. & Schlult., Annual graminoid; CTP. *11-620*

SMILACACEAE, Greenbrier Family

†*Smilax bona-nox* L., Saw Greenbrier. Woody vine; CTP. *10-1056*

ANGIOSPERMS: DICOTS

ADOXACEAE, Moschatel Family

Sambucus canadensis L., Common Elderberry. Shrub; CTP. *10-402*

ANACARDIACEAE, Cashew Family

Toxicodendron radicans (L.) Kuntze var. *radicans*, Eastern Poison-Ivy. Woody vine; CTP, ACP. *10-220*

ASTERACEAE, Aster Family

Ambrosia artemisiifolia L., Annual Ragweed. Annual herb; CTP. *11-611*

Bidens bipinnata L., Spanish Needles. Annual herb; CTP. *11-618*

Bidens frondosa L., Devil's Beggar-Ticks. Annual herb; CTP. *11-641*

***Carduus nutans* L., Nodding Musk Thistle. Annual/biennial herb; CTP. *10-424*

Conoclinium coelestinum (L.) DC., Blue Mistflower. Perennial herb; CTP. *11-653*

Conyza canadensis (L.) Cronquist var. *canadensis*, Canadian Horseweed. Annual herb; CTP. *11-616*

†**Eclipta prostrata* (L.) L., False Daisy. Annual herb; CTP. *11-529*

Erechtites hieraciifolius (L.) Raf. ex DC., Fireweed. Annual herb; CTP. *11-645*

Eupatorium serotinum Michx., Late-Flowering Thoroughwort. Perennial herb; CTP. *11-638*

**Galinsoga quadriradiata* Ruiz & Pavón, Shaggy Soldier. Annual herb; CTP. *11-647*

**Sonchus asper* (L.) Hill, Spiny-Leaved Sow-Thistle. Annual herb; CTP. *10-415*

**Taraxacum officinale* F.H. Wiggers, Common Dandelion. Perennial herb; CTP. *10-26*

Verbesina alternifolia (L.) Britton ex Kearney, Common Wingstem. Perennial forb; CTP. *11-642*
†*Vernonia gigantea* (Walter) Trel., Tall Ironweed. Perennial forb; CTP. *11-646*

CANNABINACEAE, Hemp Family
Celtis occidentalis L., Northern Hackberry. Tree; CTP, ACP. *10-394*

CAMPANULACEAE, Bellflower Family
Lobelia inflata L., Indian Tobacco. Annual herb; CTP. *11-639*

CAPRIFOLIACEAE, Honeysuckle Family
***Lonicera japonica* Thunb., Japanese Honeysuckle. Woody vine; CTP, ACP. *10-223*
***Lonicera maackii* (Rupr.) Herder, Amur Honeysuckle. Shrub; CTP, ACP. *10-215*
Symphoricarpos orbiculatus Moench, Indian Currant. Shrub; CTP, ACP. *10-1047*

CARYOPHYLLACEAE, Pink Family
***Stellaria media* (L.) Vill., Common Chickweed. Annual herb; CTP, ACP. *10-24*

CELASTRACEAE, Staff-Tree Family
***Celastrus orbiculatus* Thunb., Oriental Bittersweet. Woody vine; CTP, ACP. *10-805*
***Euonymus fortunei* (Turcz.) Hand.-Mazz. , Winter Creeper. Woody vine; CTP, ACP. *10-1049*

EBENACEAE, Ebony Family
Diospyros virginiana L., Common Persimmon. Tree; CTP, ACP. *10-398*

EUPHORBIACEAE, Spurge Family
Acalypha rhomboidea Raf., Common Three-Seeded Mercury. Annual herb; CTP. *11-627*
†*Euphorbia maculata* L., Spotted Sandmat. Annual herb; CTP. *11-640*

FABACEAE, Legume Family
Gleditsia triacanthos L., Honey Locust. Tree; CTP. *11-458*
Robinia pseudoacacia L., Black Locust. Tree; CTP. *11-452*

FAGACEAE, Beech Family
Quercus alba L., White Oak. Tree; CTP, ACP. *10-1034*
Quercus velutina Lam., Black Oak. Tree; CTP, ACP. *10-1041*

NYSSACEAE, Sourgum Family
Nyssa sylvatica Marsh., Blackgum. Tree; CTP. *10-403*

OLEACEAE, Olive Family
Fraxinus americana L., White Ash. Tree; CTP, ACP. *10-1062*
***Ligustrum obtusifolium* Sieb. & Zucc., Border Privet. Shrub; CTP. *10-333*

OXALIDACEAE, Wood-Sorrel Family
Oxalis stricta L., Common Yellow Wood-Sorrel. Perennial herb; CTP. *11-628*

PASSIFLORACEAE, Passion-Flower Family
†*Passiflora incarnata* L., Maypops. Perennial vine; CTP. *11-617*

PHYTOLACCACEAE, Pokeweed Family
Phytolacca americana L., American Pokeweed. Perennial herb; CTP, ACP. *10-868*

POLYGONACEAE, Buckwheat Family
***Persicaria longiseta* (Bruijn) Katagawa, Asiatic Smartweed. Annual herb; CTP, ACP. *10-839*
†***Persicaria maculosa* A. Gray, Lady's Thumb. Annual herb; CTP. *10-878*

ROSACEAE, Rose Family
Prunus serotina Ehrh. var. *serotina*, Wild Black Cherry. Tree; CTP, ACP. *11-117*
Rubus pensilvanicus Poir., Pennsylvania Blackberry. Perennial herb; CTP, ACP. *11-466*

SAPINDACEAE, Soapberry Family
Acer rubrum L. var. *rubrum,* Red Maple. Tree; CTP, ACP. *10-404*
Acer saccharum Marsh., Sugar Maple. Tree; ACP. *10-192*

SIMAROUBACEAE, Quassia Family
***Ailanthus altissima* (P. Mill.) Swingle, Tree-of-Heaven. Tree; CTP. *10-822*

SOLANACEAE, Nightshade Family
Solanum carolinense L. var. *carolinense*, Horse-Nettle. Perennial herb; CTP. *10-935*
Solanum ptychanthum Dunal ex DC., West Indian Nightshade. Annual herb; CTP. *11-615*

VERBENACEAE, Vervain Family
Verbena urticifolia L. var. *urticifolia*, White Vervain. Perennial herb; CTP. *11-614*

VITACEAE, Grape Family
Parthenocissus quinquefolia (L.) Planch., Virginia Creeper. Woody vine; CTP, ACP. *10-343*
Vitis vulpina L., Frost Grape. Woody vine; CTP, ACP. *10-1053*

Table 1. Frequency from thirty 1 x 1 m quadrats in a 20 x 12 m test macroplot at Dead Horse Knob Cemetery, in Madison County, Kentucky.

Family	Species	Number of Quadrats	Frequency %
Phytolaccaceae	*Phytolacca americana*	29	96.66
Oxalidaceae	*Oxalis stricta*	26	86.66
Solanaceae	*Solanum ptychanthum*	20	66.66
Asteraceae	*Erechtites hieraciifolius*	19	63.33
Polygonaceae	***Persicaria longiseta*	16	53.33
Simaroubaceae	***Ailanthus altissima*	15	50.00
Caprifoliaceae	***Lonicera maackii*	14	46.66
Caprifoliaceae	*Symphoriocarpos orbiculatus*	13	43.33
Vitaceae	*Parthenocissus quinquefolia*	13	43.33
Campanulaceae	*Lobelia inflata*	13	43.33
Fabaceae	*Robinia pseudoacacia*	12	40.00
Vitaceae	*Vitis vulpina*	12	40.00
Caprifoliaceae	***Lonicera japonica*	11	36.66
Caryophyllaceae	***Stellaria media*	9	30.00
Asteraceae	*Ambrosia artemisiifolia*	8	26.66
Asteraceae	*Eupatorium serotinum*	7	23.33
Commelinaceae	***Commelina communis*	7	23.33
Asteraceae	*Bidens bipinnata*	6	20.00
Celastraceae	***Euonymus fortunei*	6	20.00
Rosaceae	*Rubus pensilvanicus*	6	20.00
Poaceae	***Microstegium vimineum*	5	16.66
Anacardiaceae	*Toxicodendron radicans* var. *radicans*	5	16.66
Asteraceae	*Bidens frondosa*	4	13.33
Verbenaceae	*Verbena urticifolia* var. *urticifolia*	4	13.33
Celastraceae	***Celastrus orbiculatus*	3	10.00
Cannabaceae	*Celtis occidentalis*	3	10.00
Asteraceae	*Conyza canadensis* var. *canadensis*	3	10.00
Rosaceae	*Prunus serotina* var. *serotina*	3	10.00
Sapindaceae	*Acer rubrum* var. *rubrum*	2	6.66
Asteraceae	***Carduus nutans*	2	6.66
Poaceae	**Digitaria ischaemum*	2	6.66
Poaceae	**Digitaria sanguinalis*	2	6.66
Nyssaceae	*Nyssa sylvatica*	2	6.66
Poaceae	***Setaria faberi*	2	6.66
Poaceae	**Setaria pumila*	2	6.66
Asteraceae	**Taraxacum officinale*	2	6.66
Euphorbiaceae	*Acalypha rhomboidea*	1	3.33
Ebenaceae	*Diospyros virginiana*	1	3.33
Asteraceae	*Conoclinium coelestinum*	1	3.33
Cyperaceae	*Cyperus strigosus*	1	3.33
Poaceae	***Echinochloa crusgalli* var. *crusgalli*	1	3.33
Asteraceae	**Galinsoga quadriradiata*	1	3.33
Fabaceae	*Gleditsia triacanthos*	1	3.33
Oleaceae	*Fraxinus americana*	1	3.33
Oleaceae	***Ligustrum obtusifolium*	1	3.33
Fagaceae	*Quercus alba*	1	3.33
Fagaceae	*Quercus velutina*	1	3.33
Adoxaceae	*Sambucus canadensis*	1	3.33
Solanaceae	*Solanum carolinense* var. *carolinense*	1	3.33
Asteraceae	**Sonchus asper*	1	3.33
Asteraceae	*Verbesina alternifolia*	1	3.33
TOTALS:	26 families, 51 species (19 exotics), 46 genera, 323 plants		

(*)= an exotic taxon, (**)= an invasive pest plant for Kentucky (KY-EPPC 2011).

Table 2. Frequency from thirty 1 x 1 m quadrats in a 20 x 12 m reference macroplot in the Amur Honeysuckle stand adjacent to Dead Horse Knob Cemetery in Madison County, Kentucky.

Family	Species	Number of Quadrats	Frequency %
Caprifoliaceae	***Lonicera maackii*	16	53.33
Caprifoliaceae	***Lonicera japonica*	15	50.00
Caprifoliaceae	*Symphoriocarpos orbiculatus*	10	33.33
Phytolaccaceae	*Phytolacca americana*	10	33.33
Vitaceae	*Parthenocissus quinquefolia*	7	23.33
Rosaceae	*Rubus pensilvanicus*	6	20.00
Anacardiaceae	*Toxicodendron radicans* var. *radicans*	6	20.00
Cannabaceae	*Celtis occidentalis*	5	16.66
Celastraceae	***Euonymus fortunei*	5	16.66
Sapindaceae	*Acer rubrum* var. *rubrum*	4	13.33
Commelinaceae	***Commelina communis*	4	13.33
Rosaceae	*Prunus serotina* var. *serotina*	4	13.33
Vitaceae	*Vitis vulpina*	4	13.33
Poaceae	***Microstegium vimineum*	3	10.00
Caryophyllaceae	***Stellaria media*	3	10.00
Fagaceae	*Quercus alba*	2	6.66
Polygonaceae	***Persicaria longiseta*	2	6.66
Sapindaceae	*Acer saccharum*	1	3.33
Ebenaceae	*Diospyros virginiana*	1	3.33
Fagaceae	*Quercus velutina*	1	3.33
Oleaceae	*Fraxinus americana*	1	3.33
TOTALS:	15 families, 21 species (7 exotics), 18 genera, 110 plants		

(*)= an exotic taxon, (**)= an invasive pest plant for Kentucky (KY-EPPC 2011).

Table 3. Floristic composition of two 20 x 12 m macroplots at Dead Horse Knob, in Madison County, Kentucky.

Family	Species	Cemetery Test Plot	Amur Honeysuckle Reference Plot
Euphorbiaceae	*Acalypha rhomboidea*	**X**	
Sapindaceae	*Acer rubrum var. rubrum*	**X**	**X**
Sapindaceae	*Acer saccharum*		**X**
Simaroubaceae	***Ailanthus altissima*	**X**	
Asteraceae	*Ambrosia artemisiifolia*	**X**	
Asteraceae	*Bidens bipinnata*	**X**	
Asteraceae	*Bidens frondosa*	**X**	
Asteraceae	***Carduus nutans*	**X**	
Cyperaceae	†*Carex blanda*	**X**	
Celastraceae	***Celastrus orbiculatus*	**X**	
Cannabaceae	*Celtis occidentalis*	**X**	**X**
Commelinaceae	***Commelina communis*	**X**	**X**
Commelinaceae	†**Commelina diffusa*	**X**	
Asteraceae	*Conoclinium coelestinum*	**X**	
Asteraceae	*Conyza canadensis* var. *canadensis*	**X**	
Cyperaceae	*Cyperus strigosus*	**X**	
Poaceae	**Digitaria ischaemum*	**X**	
Poaceae	**Digitaria sanguinalis*	**X**	
Ebenaceae	*Diospyros virginiana*	**X**	**X**
Poaceae	***Echinochloa crusgalli* var. *crusgalli*	**X**	
Asteraceae	†**Eclipta prostrata*	**X**	
Asteraceae	*Erechtites hieraciifolius*	**X**	
Celastraceae	***Euonymus fortunei*	**X**	**X**
Asteraceae	*Eupatorium serotinum*	**X**	

Euphorbiaceae	†*Euphorbia maculata*	**X**	
Oleaceae	*Fraxinus americana*	**X**	**X**
Asteraceae	**Galinsoga quadriradiata*	**X**	
Fabaceae	*Gleditsia triacanthos*	**X**	
Oleaceae	***Ligustrum obtusifolium*	**X**	
Campanulaceae	*Lobelia inflata*	**X**	
Caprifoliaceae	***Lonicera japonica*	**X**	**X**
Caprifoliaceae	***Lonicera maackii*	**X**	**X**
Poaceae	***Microstegium vimineum*	**X**	**X**
Nyssaceae	*Nyssa sylvatica*	**X**	
Oxalidaceae	*Oxalis stricta*	**X**	
Poaceae	†*Panicum dichotomiflorum*	**X**	
Vitaceae	*Parthenocissus quinquefolia*	**X**	**X**
Passifloraceae	†*Passiflora incarnata*	**X**	
Polygonaceae	***Persicaria longiseta*	**X**	**X**
Polygonaceae	†***Persicaria maculosa*	**X**	
Phytolaccaceae	*Phytolacca americana*	**X**	**X**
Rosaceae	*Prunus serotina* var. *serotina*	**X**	**X**
Fagaceae	*Quercus alba*	**X**	**X**
Fagaceae	*Quercus velutina*	**X**	**X**
Fabaceae	*Robinia pseudoacacia*	**X**	
Rosaceae	*Rubus pensilvanicus*	**X**	**X**
Adoxaceae	*Sambucus canadensis*	**X**	
Poaceae	***Setaria faberi*	**X**	
Poaceae	**Setaria pumila*	**X**	
Smilacaceae	†*Smilax bona-nox*	**X**	
Solanaceae	*Solanum carolinense* var. *carolinense*	**X**	
Solanaceae	*Solanum ptychanthum*	**X**	
Asteraceae	**Sonchus asper*	**X**	
Caryophyllaceae	***Stellaria media*	**X**	**X**
Celastraceae	*Symphoricarpos orbiculatus*	**X**	**X**
Asteraceae	**Taraxacum officinale*	**X**	
Anacardiaceae	*Toxicodendron radicans* var. *radicans*	**X**	**X**
Verbenaceae	*Verbena urticifolia* var. *urticifolia*	**X**	
Asteraceae	*Verbesina alternifolia*	**X**	
Asteraceae	†*Vernonia gigantea*	**X**	
Vitaceae	*Vitis vulpina*	**X**	**X**
TOTALS:	61 taxa	60 taxa	21 taxa
QUADRATS ONLY:	52 taxa	51 taxa	21 taxa

(*)= an exotic taxon, (**)= an invasive pest plant for Kentucky (KY-EPPC 2011), (†)=found in macroplot but not in quadrats.